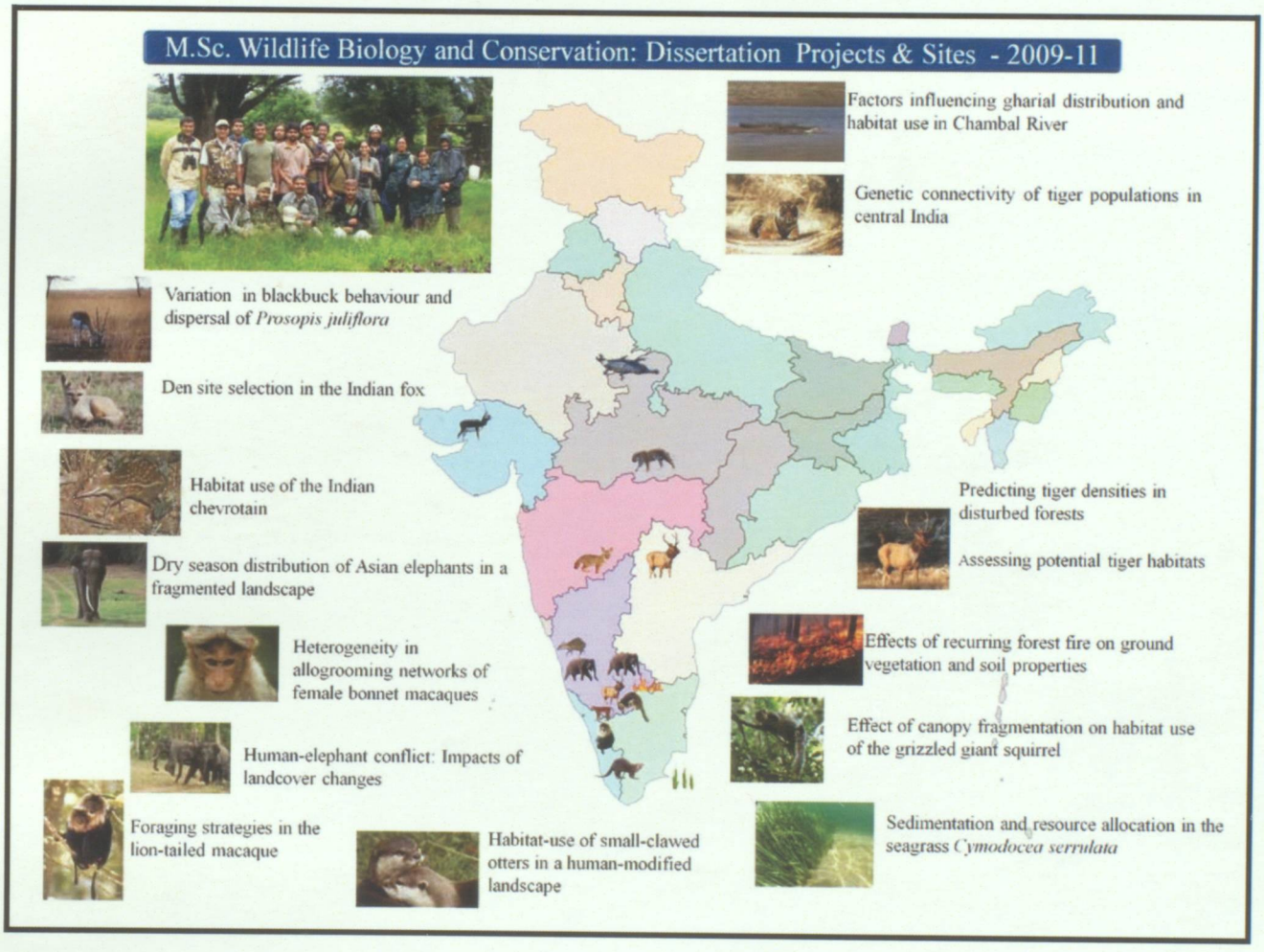
Research on Wildlife biology and Conservation by Students of a Masters Course in National Centre for Biological Sciences, Bangalore



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PROJECT SUMMARY

The dearth of wildlife scientists has been a major handicap in research on India's wildlife and its conservation. The 2-year M.Sc. course in Wildlife Biology and Conservation offered by the National Centre for Biological Sciences (NCBS) in Bangalore and Centre for Wildlife Studies, Bangalore, aims to train 15 students once in two years to conduct high quality research. In 2009 SERC (Animal Sciences) of DST, provided a grant of Rs.29,42,900 to NCBS; (a) to set up teaching laboratory in wildlife biology; and (b) to support 15 dissertations by the Masters students. The teaching laboratory in NCBS was equipped microscopes and a PCR machine which were used to train the students in analysis of diet of carnivores, plant identification, and in the analysis of tissue and fecal DNA. The grant also supported 15 dissertations. The students started developing their research proposals in July 2009 with assistance from a Dissertation Advisory Committee set up for each student, and defended their proposals in a public seminar in October 2009. Eighteen faculty from 14 institutions served in the Dissertation Advisory Committees. The dissertation projects, spread across 9 states, included those on highly endangered species such as the tiger, elephant, and gharial and in habitats ranging from seagrass meadows to tropical rainforest. The dissertations, submitted in the first week of July 2010, were evaluated by two external academicians and defended, in the presence of nearly 100 researchers. At the time of writing this report, a total of 12 papers are in different stages of publication in peer reviewed journals of high impact factor: 4 published; 2 resubmitted after revision; 3 in review and 3 due for submission in the coming month. The students also made presentations of their dissertation project in 11 international seminars in six countries, winning 4 best presentation awards. Thus this project has accomplished its goal of training Masters students in high quality research, as evidenced by publications in high impact journals. The project also addressed information gaps critical to the conservation of endangered species such as the tiger, elephant and gharials, and increased our understanding of the ecology of several other species such as the Indian fox, lion-tailed macaque, grizzled giant squirrel and blackbuck.

ACKNOWLEDGEMENTS

The Investigators of this project, the Masters students and their guides acknowledge funding for this project from SERC (Animal Sciences), Department of Science and Technology; without this support the dissertations and publications would not have been possible. We would particularly like to thank the following persons who have helped this project in various ways, often without being asked:

- Late Dr.Veronica Rodrigues, Chairperson of the PAC (Animal Sciences) in 2008-09;
- Prof.Mewa Singh, Chairman-in-Charge of the PAC (Animal Sciences) from 2009;
- Dr.B.P.Singh, Director, SERC Division in 2008-10; and
- Mr.Doyil Vengayil, SERC Division;

We would also like to thank Drs.Marimuthu, Sushil Dutta and Vinod Kumar for their advice and support.

We thank the Chief Wildlife Wardens and their field staff in ten states for research permits and other assistance. Between Mr.Doyil Vengayil in SERC-Delhi and, Mr.Pradip Pyne (Head of Admin & Finance), Mr.Ashok Rao (Head, Administration) and Mr.Purushotham, V.S. (Head, Finance) in NCBS, we had the most seamless and efficient administration of the project. Finally, we wish to thank all the students and their guides; whatever this project has achieved is entirely due to them; and whatever is has not is due to us.

CONTENTS

OBJECTIVES OF THE PROJECT

Background

Despite substantial resource commitments by the Indian government, NGOs and international agencies, the conservation of India's biodiversity has been severely handicapped by the lack of trained wildlife scientists who can design, implement and monitor conservation projects. Recognizing this, a group of reputed biological research institutions came together in 2004 to start a Masters course in Wildlife Biology and Conservation. The National Centre for Biological Sciences (NCBS), a premier research institution in Bangalore, provided the infrastructural facilities. The Centre of Wildlife Studies (CWS), Bangalore, well known for research on large carnivores, raised funds for an initial period of six years from Wildlife Conservation Society, New York to cover operating costs. CWS also coordinated the academic programme. The Masters Degree is awarded by the Tata Institute of Fundamental Research (TIFR), Mumbai, a prestigious Deemed University. This 2-year course is offered every alternate year to 15 students who are competitively selected through entrance tests in 29 centres in India, followed by a personal interview. During the last six months of the course students carry out conservation related research projects, based on which each student is required to submit at least one manuscript for publication in a peer reviewed journal. Through this project, students apply the theory and skills gained in the preceding 18 months to conceptualize, design, implement, analyze and publish original research. These projects also provide critical information required for the conservation and management of Indian wildlife. Thus this Program provides high quality training to wildlife biologists, at the same time addressing critical areas in wildlife biology and conservation. The dissertation projects of the first two batches of 30 students resulted in 25 publications in peer reviewed journals of high impact factor; a record unparalleled in India and perhaps so internationally. These projects also resulted in nearly 20 presentations in international seminars in 10 countries, winning several best presentation awards, and several popular articles in magazines and newspapers.

In this background, NCBS applied for a grant from the Department of Science and Technology to set up a teaching laboratory in wildlife biology, and to support 15 research projects of Master's students in 2009-12. Appreciating the track record of publications at the Masters level, DST-Animal Sciences approved a grant of Rs.29,42,900 in February 2009.

Objectives

The overall goal of this project was to train 15 Masters students in high quality research in wildlife biology and conservation. The specific objectives were:

1) To set up a teaching laboratory in wildlife biology at NCBS to train students in the use of microscopes in plant identification and the analysis of carnivore scats, and in the extraction and analysis of fecal and tissue DNA for species identification;
2) To train one batch of 15 Masters students in high quality research by assisting them in project design, data collection and analysis and in the preparation and submission of manuscripts for publication; and
3) To fill some of the critical gaps in information in the field of wildlife biology and conservation through the dissertation projects of the Masters students.

METHODS

Identification of dissertation projects

Preparation for dissertation projects began in July 2009, when the students began informally discussing their ideas within the class and with the faculty. A formal presentation of their ideas took place in September during a seminar in which most of the faculty also participated. If the ideas were original and feasible, then a Dissertation Advisory Committee, consisting of 2 or 3 faculty with complementary expertise was set up for each student. The student then worked very closely with this Committee to develop the ideas into a project proposal, within a budget of about Rs.100,000 each, which was circulated among all faculty and then publicly defended in the first week of October 2009. The final proposal, incorporating suggestions during the defense, was submitted in the last week of October 2009.

Project implementation

When finally approved, the 15 fifteen dissertation projects were spread out in 10 Indian states, in habitats ranging from sea grass meadows to rainforests, and on taxa ranging from plants to primates. The projects were supervised by 18 eminent scientists from 15 organizations (Table 1).

During September to November, the academic office communicated with the forest departments in ten states to obtain research permits. This most challenging task was completed by the second week of November. We also ensured that all the equipment was procured and advances for field data collection were disbursed. Most of the students left for their field study sites (Figure 1) in the first week of December. We interacted with the members of the Dissertation Advisory Committee to ensure that each student was visited by least one of the Committee members within the first month of starting field data collection.

The methods used for data collection varied widely, depending on the project objectives. These are briefly described in the abstracts of dissertations given below, and described in detail in the papers that have been published or are under review (Appendix 1).

Most of the students returned to NCBS by the first week of May and spent the next two months in data analysis and preparation of the dissertation, most of them as the first draft of a manuscript for submission to an international peer reviewed journal. We ensured that the members of the Advisory Committee were available for ongoing consultation and supervision of data analysis and writing. All students submitted their dissertations by the 1st of July 2010.

Dissertation evaluation and defense

Each dissertation was evaluated by two external examiners, and then publicly defended in a seminar attended by more than 100 researchers. This seminar was also attended by Dr.B.P. Singh, who was then the Director of DST-SERC Division. All the students successfully defended their dissertation and were awarded Masters degree by the Tata Institute of Fundamental Research.

Submission of manuscript for publication

The students were provided with a fellowship from the DST project to stay back to finalize the manuscripts for publication. Some students were able to do this and submit the manuscripts for publication. Some others needed further analysis of data and therefore

could submit manuscripts only a few months later. The results from 3 dissertations were not significant enough to warrant publication in good journals. As on 31st of March 2012, 8 papers have been either accepted or are under review (Table 2), and five are nearing completion.

RESULTS INDICATING CONTRIBUTIONS MADE TOWARDS INCREASING THE STATE OF KNOWLEDGE IN THE SUBJECT:

The results from each dissertation are briefly described below. A detailed description can be found in papers that have been either published or under review (Appendix 1).

Predicting tiger (*Panthera tigris*) densities based on prey abundance in disturbed forests of Kawal Wildlife Sanctuary in Andhra Pradesh: *Imran Siddiqui*

As an obligate predator of large ungulates, the tiger *(Panthera tigris*) is an ideal umbrella species for the protection of large tracts of forests. However, the tiger has lost 93% of its historical range and its current status is precarious over large expanses of surviving forests in peninsular India. Over half of the remaining potential tiger habitat in India consists of dry deciduous forests (DDF) that are often under significant human pressures. My study area, Kawal Wildlife Sanctuary (KWS) typifies such forests; the 893 km2 sanctuary has several villages within and adjacent to it, exerting considerable pressure on the forests and wildlife. The overall goal of the study was to assess densities of principal tiger prey species and to use these estimates to predict potential current carrying capacity of tigers in KWS, as well as to assess human-related factors currently limiting prey densities. Densities of tiger prey species were estimated using line transect sampling of 18 spatial replicates spread over the selected study area of 502 km2. A total sampling effort of 478 km resulted in 383 detections of large herbivores. The same transects were also used for quantifying human impacts by measuring three types of human disturbance measures (continuous, binary and proximity). These covariates were later combined to derive a cumulative human disturbance index (HDI). Ungulate densities in KWS were generally low, except in the case of wild pig and their densities ranged from 0.4 sambars/km^2 to 8 wild pigs/km^2. The overall density of principal tiger-prey species was estimated to be 13.5 ungulates/km^2, with the overall biomass estimated as 819 kg/km^2 excluding livestock. The current wild prey base is likely to support 2.7 tigers/100 km^2. Human impacts were generally high and wide-spread. Regression analyses indicated that human disturbance had a negative influence on encounter rates of ungulate prey, suggesting that ungulates are currently limited by human disturbance and can recover to the much higher levels recorded in other ecologically similar habitats, if appropriate management interventions are put in place. This study has resulted in the first ever ungulate density estimates for Kawal, which are invaluable as benchmarks to measure future changes in response to management interventions. Despite the currently low densities of ungulate prey in KWS, the sanctuary has tremendous potential for both tigers and their prey. Reduction in pressures such as cattle grazing and hunting is required before ungulates and tigers can recover to their potential levels. A more comprehensive conservation monitoring scheme will aid in tracking the recovery of tiger and prey populations in this high potential landscape.

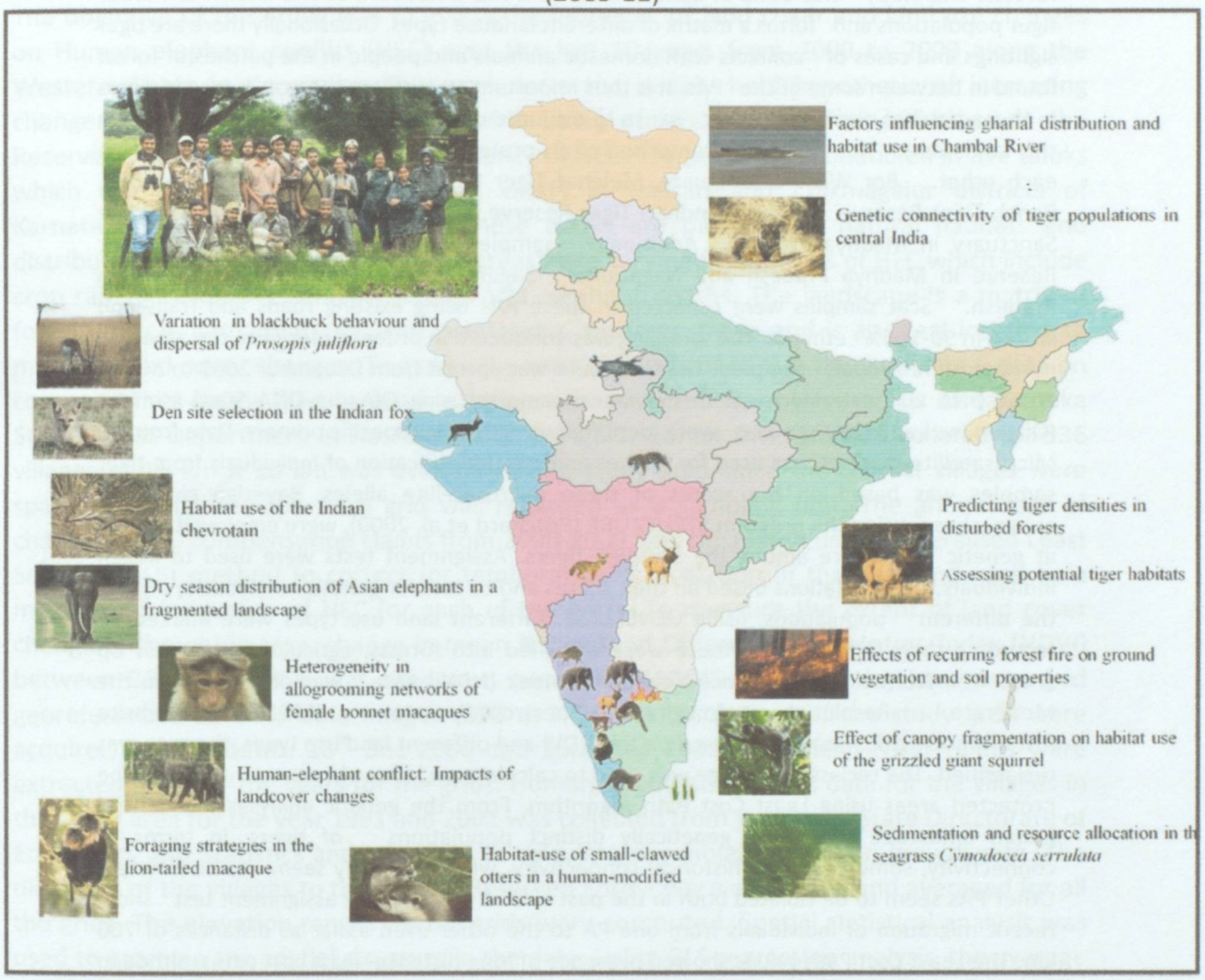
Table 1. Dissertation projects of 15 student of M.Sc. Wildlife Biology and Conservation

Student	Dissertation title	Guides
Aditya Joshi	Genetic Structure and Connectivity of Tiger (*Panthera tigris tigris*) Populations in Central Indian Forests	UR, AE
Bipin C.M	Human Elephant conflict: Impacts of landcover changes along the Western Ghats	RC
Girish A. Punjabi	A multi-scale approach to examine factors influencing den site selection in the Indian fox *Vulpes bengalensis* in a human dominated dry grassland ecosystem in peninsular India	RC, AT
Imran Siddiqui	Predicting tiger (*Panthera tigris*) densities based on prey abundance in disturbed forests of Kawal	KUK, NSK
Ipsita Herlekar	Effect of canopy fragmentation on the patterns of habitat use of the grizzled giant squirrel *Ratufa macroura* in Cauvery Wildlife Sanctuary, Karnataka, India.	KI
Jayendra Baliga	Analysis of behaviour in Primate social networks	AS
Killivalavan Rayar	Assessing potential tiger habitats in Cauvery Wildlife Sanctuary, Karnataka using occupancy modeling approaches	KUK, NSK
Mayuresh Gangal	Sedimentation Influences resource allocation in the seagrass *Cymodocea serrulata*	RA, TP
Meghna Krishnadas	Foraging strategies and patterns of home range use by an obligate frugivore, the lion-tailed macaque (*Macaca silenus*) in relation to resource availability	AK, KC
Nisarg Prakash	Factors influencing the occurrence and habitat use of small- clawed otters *(Aonyx cinerea)* in the human-modified landscape of Western Ghats, South India	AK, DM
Nishant Srinivasaiah	Determinants of dry season distribution of Asian elephant (*Elephas maximus*) in a fragmented landscape of Eastern Ghats, Southern India and implications for human - elephant conflict	AS, VS
Rajat Nayak	Effects of recurring forest fire on ground vegetation composition and soil properties in a South Indian tropical forest	JK, VS
Sachin Sridhara	Habitat use of the Indian chevrotain (*Moschiola indica)* in Someshwara Wildlife Sanctuary	AE
Shivani Jadeja	Effect of intraspecific variation in blackbuck behaviour on dispersal of invasive *Prosopis juliflora* in a semi-arid grassland	KI, SQ, SP
Tarun Nair	Ecological and anthropogenic covariates influencing gharial *Gavialis gangeticus* distribution and habitat use in Chambal River, India	JK, PA

AE – Advait Edgaonkar[14], **AK** – Ajith Kumar[3,6] ,**AS** – Anindya Sinha[5,6], **AT** – Abi Tamim Vanak[13], **DM** – Divya Mudappa[2], **JK** – Jagdish Krishnaswamy[1,6], , **KC** – K.Chandrashekhara[11], **KI** Kavita Isvaran[4] , **KUK** – Ullas K. Karanth[6,7], **NSK** – N.Samba Kumar[3,7], **PA** – Patrick Aust[12], **RA** – Rohan Arthur[2], **RC**- Ravi Chellam[3,7], **SP** – Soumya Prasad[4], **SQ** – Suhel Quader[6], **UR**- Uma Ramakrishnan[6], **TP** –Teresa Pedrola[10] , **VS** – V.Srinivas[9]

(1) Ashoka Trust for Research in Ecology and Environment, Bangalore (2) Nature Conservation Foundation, Mysore (3) Wildlife Conservation Society-India Program (4) Centre for Ecological Studies, Indian Institute of India, Bangalore (5) National Institute for Advanced Studies, Bangalore (6) National Centre for Biological Sciences, Bangalore (7) Centre for Wildlife Studies, Bangalore (8) Wildlife Conservation Society (9) FERAL,Pondicherry (10) Centro de Estudios Avanzados de Blanes,Spain. (11) University of Agricultural Sciences, GKVK, Bangalore (12) Madras Crocodile Bank Trust (13) University of Kwazulu-Natal, South Africa. (14) Indian Institute of Forest Management, Bhopal.

Figure 1. Study sites for dissertations of students of M.Sc. Wildlife Biology and Conservation (2009-11)



Genetic structure and connectivity of tiger (*Panthera tigris tigris*) populations in central Indian forests: *Aditya Joshi*

Given that more than 60% of the global tiger population is in India, it is essential to consider the effects of rapid growth and development on the habitat of this critically endangered species. Tigers mostly occur in low densities and have wide ranging movements, rendering them highly susceptible to effects of habitat fragmentation. Very few studies in India have focused on the importance of forest patches present between large protected areas for dispersal and connectivity of large carnivores. It is difficult to get at dispersal rates using capture- recapture framework or radio-tracking, as long distance dispersal events are rare (Berger 2004). Genetic approaches provide information about the population history as well as the relatively recent dispersal events. DNA material can be obtained without capturing animals using non-invasive samples, for example from feces. Studies that combine genetic and landscape structure data will carnivore like the tiger. This study was done to assess the connectivity of tiger populations in Central India along with the structural connectivity of

forests. The study was done in Central India as it has a network of PAs known to harbor tiger populations and forms a matrix of different landuse types. Occasionally there are tiger sightings and cases of conflicts with domestic animals and people in the patches of forest found in between some of the PAs. It is thus important to evaluate the occurrence of tigers in these patches and in a broader sense to evaluate connectivity and dispersal of tigers in this landscape. The study area comprised of six protected areas at varying distances from each other. Bor Wildlife Sanctuary, Melghat Tiger Reserve, Nagzira Wildlife Sanctuary, Pench Tiger Reserve, Tadoba – Andhari Tiger Reserve, all in Maharashtra and Bori Wildlife Sanctuary in Madhya Pradesh . Additional samples were obtained from Kanha Tiger Reserve in Madhya Pradesh and Nagarjuna Sagar-Srisailam Tiger Reserve in Andhra Pradesh. Scat samples were collected in these PAs using existing roads and trails and stored in 90-100% ethanol. The sampling was conducted in order to maximize the area and number of individuals sampled. The field work was spread from December 2009 to March 2010. DNA was extracted from the faecal samples using QIAamp DNA Stool Mini Kit (Qiagen Inc.) and tiger samples were identified using species-specific primers. Data from 10 Microsatellite markers was used for further analysis. Identification of individuals from tiger samples was based on the scores of these microsatellite alleles. Bayesian clustering approaches, using the program STRUCTURE (Pritchard et al. 2000), were employed to look at genetic structure among the sampled tigers. Assignment tests were used to assign individuals to populations based on their scores and to test for genetic connectivity among the different populations, using GENECLASS. Different land use types were marked by recording their GPS location; these were classified into forests, agriculture and built up areas. The Normalized Difference Vegetation Index (NDVI) data was obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) website (http://modis.gsfc.nasa.gov/). Based on the NDVI and different land use types, the area was reclassified. The reclassified image was used to calculate an index of connectivity within the protected areas using Least Cost Path Algorithm. From the genetic analyses the Central Indian landscape showed 5 genetically distinct populations of tigers. In terms of connectivity, some PAs show historical connectivity, while now they seem to be isolated. Other PAs seem to be isolated both in the past and at present. The assignment test show recent migration of individuals from one PA to the other even as far as distances of 700 km. The Least Cost Path values showed presence of long distance- least cost paths, although developments in the methods used for assessing connectivity are suggested so as to measure connectivity of habitats more efficiently. This study is the first of its kind and provides information on the connectivity of tiger populations using genetic and GIS data. Such studies allow identification of important areas in a protected area network and help in prioritization of conservation effort outside protected areas.

Human Elephant conflict: Impact of land cover changes along the Western Ghats in Karnataka: ***Bipin, C.M.***

The objective of this study was to assess the influence of land cover and land use changes on Human elephant conflict (HEC) over the last 10 years from 2000 to 2009 along the Western Ghats in Karnataka. This work tests the widely held hypothesis of increasing changes of natural habitats escalating frequency of HEC and proximity of areas to the Reserved Forests exhibiting higher frequency of HEC. The study was conducted in five taluks which are contiguous along Western Ghats in Hassan and Chikmagalur districts of Karnataka. The Reserved Forests in these taluks are part of the natural habitats and distribution ranges of elephants. These areas have varying frequencies of HEC which include crop raiding, property damage, human and elephant deaths. The landscape is a matrix of forest, coffee, cardamom, coconut plantations and crop fields and is an ideal location to measure land cover changes. To assess the existing levels of HEC in the study area, data on compensation claims filed by local residents was collected from the records of Karnataka State Forest Department in Hassan and Chikmagalur Forest Divisions and collated for 336 villages. A 10 km X 10 km was overlaid on the study area since the conflict villages were spatially contiguous and each grid was regarded as a sampling unit. The annual rate of change of HEC compensation claims from 2000-2009 was calculated using Generalised Least Squares (GLS) method to correct for temporal autocorrelation in the data and used as a measure of frequency of HEC for each of the grids. To measure the extent of land cover change in the study area, change in mean Normalized Differential Vegetation Index (NDVI) between 2000 and 2009 was used as a surrogate. MODIS NDVI 16- day composite grid georeferenced satellite data images (250 m X 250 m resolution) of the study area were acquired for the dates: 18th Dec 2000 and 18th Dec 2009. The mean NDVI values were extracted for both the years for the grids. Human population census data for the villages in the study area for the year 1991 and 2001 was collected from Karnataka State Directorate of Economics and Statistics and tabulated to calculate decennial population growth rate. The distances of the villages to the nearest Reserved Forest were computed and averaged for all the grids. The elevation ranges for the grids were computed. Spatial statistical analysis was used to examine the spatial structure in the data. Using GLS regression analysis, the average difference in NDVI, a proxy for landcover change was found to influence frequency of HEC. Grids with low elevation range showed higher frequency of HEC. Proximity to Reserved Forests did not seem to influence frequency of HEC. Though decennial growth rate of human population showed a positive association with the HEC rate, spatial correlation indicates that it is probably an artifact of spatial proximity of villages showing high growth rate than a true relationship. Frequency of HEC was modeled as a function of landcover change and elevation range. Though NDVI as an index is a good measure of landcover change, there are several analytical issues associated with its interpretations which warrants a judicious use of NDVI in landcover change studies. Post classification of NDVI images and multi temporal image analysis would corroborate the results to draw stronger inferences about the influences of landcover change on HEC.

A multi-scale approach to examine factors influencing den site selection in the Indian fox *Vulpes bengalensis* in a human dominated dry grassland ecosystem in peninsular India: *Girish Punjabi*

Resource selection is a multilevel and hierarchical process where an individual behaves in response to various environmental factors. The selection of denning sites can be considered as a form of resource selection, and thus the availability of denning sites for many carnivores can potentially limit their distribution and abundance. In this study, I looked at factors affecting den site selection in the Indian fox. I examined two scales: the 'home-range' scale, and the 'den-area' scale. I conducted the study around the Great Indian Bustard Sanctuary in Solapur district, Maharashtra. I systematically surveyed the landscape to search for active breeding Indian fox dens. I measured habitat attributes around each den site and at four available sites for each den. I created a GIS land cover map of the study area to measure other land use variables. I used an information theoretic approach (Burnham and Anderson, 2002) of testing *a priori* hypotheses. At the largest scale, I used generalized linear mixed effect models to look at the effect of land use type at various scales. For the den area scale, I used discrete choice models to test the effect of the 4 *a priori* models on den site selection. I used the AICc and Akaike weights criterion to compare the best fit models at each scale. I found grasslands to be the most influential factor underlying den site selection at the home range level at the 100m scale. At the den area scale, I found grasslands, fallow land and plantation along with number of rodent burrows to be the top model. Grasslands and number of rodent burrows were the strongest effects in the selection of a den site at the den area scale. The result indicates the importance of grasslands for reproductive denning in the Indian fox. Tropical dry grassland biomes are highly endangered and therefore greater protection to these habitats will ensure long term survival of all species including the Indian fox.

Effect of canopy fragmentation on the patterns of habitat use of the grizzled giant squirrel *Ratufa macroura* in Cauvery Wildlife Sanctuary, Karnataka, India*: Ipsita Herleker*

This study examines the factors that influence the patterns of habitat use of grizzled giant squirrel and their nest site selection in the linear riparian forest patches of Cauvery Wildlife Sanctuary, Karnataka, India. Habitat structure, food availability and human disturbance are hypothesized to be the main ecological factors influencing the habitat use of the squirrel. The entire study area was divided into 45 segments of 500 m x 30 m, which were further sub-divided into 100 m x 30 m cells. These segments were walked by two trained people between 0700h-1300h and all direct signs (animal sightings) or indirect signs (nests) of use by the squirrel were recorded. Nests were considered as an estimate of habitat use. Ecological variables including habitat structure, food availability and human disturbance were measured in each 100 m x 30 m cell. This study also evaluated the factors affecting nest site selection of the grizzled giant squirrel. Circular vegetation plots of 10 m radius were laid around the trees where nests were located and in sites without nests that were sampled randomly and the habitat structure and food availability in these sites were measured and noted respectively. The results of habitat use of the squirrels showed that, at smaller habitat scale, which is focused around nest sites, canopy connectivity and human disturbance together influence habitat use of the squirrel. At larger home-range level scale, habitat use was mainly related to a joint effect of canopy connectivity and food abundance.

Results on the nest site selection of the squirrels indicate that habitat structure and food availability influenced the nest site selection .The variables canopy connectivity and number of individual food trees in an area interact with one another to show a pattern where sites with low food abundance are selected in the presence of high canopy connectivity The study highlights the importance of canopy connectivity for arboreal mammals at small nest site scale, large home range scale and for the selection of nest sites.

Assessing potential tiger habitats in Cauvery Wildlife Sanctuary, Karnataka using occupancy modeling approaches: ***R. Killivalavan***

Focused management and conservation actions targeted at tigers or their prey species are most likely to be effective if key factors influencing variation in the occupancy and abundance of ungulate prey can be identified and assessed reliably using rigorous population sampling methods. My study assessed the current potential of Cauvery Wildlife Sanctuary, Karnataka to support populations of the principal tiger-prey species (gaur, sambar, chital, wild pig, four-horned antelope and muntjac), by determining their occupancy and relative abundance using occupancy modeling approaches based on detection of animal signs. I also investigated the role of potential habitat-related factors in determining probability of occupancy and local abundance of ungulates. Using an innovative small-cell occupancy survey design, I surveyed a total of 142 grid cells, each of 3.25 km^2in area, which spanned the entire study area. 205 direct sightings and 1280 indirect evidences (fresh animal dung and tracks) of the study species were recorded during 532 km of walk-efforts, which formed the basis for occupancy analysis. I also used Hayne's (1949) line transect estimator to derive independent estimates of ungulate densities from direct sightings of the study species. The Royle and Nichols (2003) occupancy model, the standard MacKenzie *et al.* (2002) model as well as the new Hines *et al.* (2010) models, when used in combination, produced a reliable estimate of occupancy and relative abundance of ungulates. The estimated proportion of sites occupied (ψ) varied from 0.08 (SE 0.02) for muntjac to 0.88 (SE 0.04) for sambar. The site-specific cluster abundance (λ) was highest for sambar (2.12 SE 0.36). The derived animal densities (in km^{-2}) ranged from 0.03 (for muntjac) to 2.45 (for chital) animals. The density of the four-horned antelope (0.69 km^{-2}) was higher than many of the other sites in India underlining the importance of the area for the long term persistence of this species. However, the density estimates obtained from line transect Hayne's estimator seemed to be biased positively relative to the occupancy-based density estimates, possibly due to violations of some of the distance sampling assumptions. The combined ungulate density was 5.1 km^{-2} and the derived density of tiger was 1/100 km^2. The technical and logistical advantages of using occupancy-based approaches to estimating abundance based on animal signs make it a feasible tool for regular and large-scale monitoring of ungulate prey populations. Over-grazing by livestock appears to be the strongest limiting factor for ungulate abundance. Given the productive nature of well-protected deciduous forests and their ability to support high densities of tigers and prey, Cauvery Wildlife Sanctuary provides a strong opportunity to conserve tigers and their prey in this high potential landscape through suitable management interventions. at Cauvery Wildlife Sanctuary is very low compared to other well-protected dry deciduous forests in India, thus clearly indicating that ungulate densities are well below the potential ecological carrying capacity of the area. Abundances of chital, sambar, wild pig and four-horned antelope were all negatively influenced by the proximity and size of livestock populations.

Sedimentation Influences resource allocation in the seagrass *Cymodocea serrulata:* *Mayuresh S. Gangal*

Seagrass meadows serve many vital ecological functions such as providing spawning sites for diverse biota, providing food to many herbivores, stabilizing the substratum and contributing in productivity of coastal waters. Today, a global decline is observed in seagrass ecosystems worldwide. Many anthropogenic and natural factors are identified as a cause for this decline. Among these factors, sedimentation is responsible for reduction in light availability and increase in nutrient load and is considered as a major stressor. In spite of having high sedimentation regime, coastline of Palk bay and Gulf of Mannar harbours one of the richest seagrass meadows in the world. In this study I looked at how the dominant seagrass *Cymodocea serrulata* copes with differential sediment pressure. The study was carried out from 1st March 2010 to 19th May 2010 across seven sites. Four in Gulf of Mannar and three in Palk bay were chosen for the study. These sites were chosen in order to get maximum variation in sedimentation regime. I have measured sedimentation rates in all the seven sites with the help of sediment traps. I have taken a total of 63 seagrass cores across seven sites to understand the relationship between sedimentation, shoot density and biomass. I have also marked some shoots of the seagrass and measured their growth at each site to understand the effect of sedimentation on production of leaves. I saw that there was no correlation between sedimentation rates and shoot density as well as production of *Cymodocea serrulata.* However I found the shoot: root ratio exponentially decreasing with increase in sedimentation. From the above result I inferred that with the increase in sedimentation, *Cymodocea serrulata* responds by increasing their below ground biomass and allocating more resources to rhizomes rather than leaves. This study although restricted for only one year, one season gives a general idea about how and at what levels (energy allocation and population) seagrass copes with the sedimentation stress.

Foraging Strategies and Patterns of Home Range Use by an Obligate Frugivore, the Lion-tailed Macaque (*Macaca silenus*) in Relation to Resource Availability: *Meghna Krishnadas*

Tropical rainforests are known to display peaks of fruiting in sync with the peaks in annual rainfall. This temporal clumping of fruit production results in a seasonal fluctuation of resources available to frugivores. To overcome this stress, animals may expand their dietary width to include less nutritive but more abundant foods, or selectively forage more in areas where higher energy yields are likely, depending on their digestive system. I studied the response of an obligate frugivore, the lion-tailed macaque, endemic to the rainforests of the Western Ghats, to changing patterns of resource distribution and availability within its home range. I hypothesized that during the period of resource limitation the Lion-tailed macaque would fall back on relatively high quality food in the habitat, and would track such resources more closely. I undertook this study in Silent Valley National Park, Kerala from January to early May 2010. One group was habituated and studied intensively. I estimated the abundance and density of major food trees in an area of 1.75 km2 within the home range of the group using 348 point centered quadrats. I also monitored the fruiting phenology of 15 major food tree species. Time spent on various activities and feeding on different food species were estimated from group scans; the location of the group was recorded at 15 minute intervals using a GPS. The fruits of 12 species fed upon by the group

were analyzed for the major macronutrients. The data was analyzed in two periods, February to mid March (Period 1) and late March to April end (Period 2). My study shows that there exists a clear period of resource scarcity in the rainforest, both in terms of quantity and quality. Percentage of trees in fruit and the nutritional quality of the fruits was significantly higher during Period 2. Percentage time feeding was higher in Period 2. Percentage time moving, inclusive of ranging was discernibly higher during Period 1. During the lean period, the group spent maximum time feeding on a relatively high quality, patchily distributed resource and seemed to track and selectively consume high quality resources. The probability of feeding increased with the resource concentration in an area. In contrast, during the period of higher resource availability, no relationship was observed between resource abundance in an area and probability of feeding.

Factors influencing the occurrence and habitat use of small- clawed otters *(Aonyx cinerea)* in the human-modified landscape of Western Ghats, South India: *Nisarg Prakash*

Otters are top predators of aquatic and semi-aquatic ecosystems but remain one of the most understudied groups of mammals. They face major threats in the form of habitat loss, modification and poaching, and unlike other carnivores sizeable populations exist outside the protected area network making them highly vulnerable. This study examined the influence of land-use types and stream characteristics on the occurrence and habitat-use of small-clawed otters in the highly modified and fragmented landscape of the Anamalai hills. I conducted this field study from January to May 2010 in the Valparai plateau and the surrounding forests of the Anamalai Tiger Reserve, in order to identify factors influencing the occurrence and use of habitat in a human dominated landscape. I systematically surveyed 66 perennial streams, of which 42 were in tea and coffee plantations. Signs of otters were recorded, and habitat covariates that could influence otters were measured at regular intervals. Spraint encounter rate for each segment was treated as an index of intensity of habitat use and this was modelled as a function of various habitat covariates. Only the small-clawed otter was recorded on camera traps in the sampled area. There was no difference in the occupancy of otters among the three land-use types. The numbers of refuges and shoreline diversity had a strong combined influence, and land-use had an independent effect on the intensity with which streams were used by small-clawed otters, which was higher in the protected area. Small-clawed otters occur in the Valparai plateau because the stream properties have not been fundamentally altered due to the presence of forest fragments, riparian vegetation and the presence of protected areas all around. The human modified landscape is less used than the surrounding protected area because of human disturbance such as sand mining, fishing, and poaching. It is important to protect streams and their associated riparian habitats outside reserves, jointly by both the private landholders and the forest department to ensure the otter's survival.

Determinants of dry season distribution of Asian elephant (*Elephas maximus*) in a fragmented landscape of Eastern Ghats, Southern India and implications for human - elephant conflict: *Nishant M. Srinivasaiah*

In highly fragmented and human dominated landscape such as the Eastern Ghats, the elephants have to navigate across a mosaic of human habitations and forests to acquire their resources. An investigation into understanding how elephants continue to persist in

such human–dominated landscapes is essential for conservation planning, management of protected areas and human welfare at a landscape level. Ranging behaviour of elephants in these landscapes can be expected to be influenced by ecological factors such as forage, water and cover and also human induced factors. In this study I try and uncover the factors influencing ranging behaviour of elephants in fragmented landscapes of the Eastern Ghats, with specific reference to Bannerghatta National Park (BNP) and adjoining human habitations. I hypothesize that forage, shade and water availability, the ecological covariates, will have a positive effect on the distribution of elephants and human induced factors would have a negative effect on the same. I also hypothesize that there will be a tradeoff between resource acquisition and risk avoidance by elephants in order to continue to persist in such a landscape. I employed grid based field techniques of direct and indirect observations of elephants to collect data on elephant patch/grid preference and time spent by elephants in each of the 34 sampled grids. Data on ecological covariates namely forage, shade/cover and water was estimated from Moderate resolution imaging radiospectrometer (MODIS) images. Normalized Difference Vegetation Index (NDVI) and Leaf Area Index (LAI) were used as estimates of forage and shade/cover available respectively. Number of water sources and human/human related disturbances in each of the grid was estimated during the grid based habitat survey. Employing statistical techniques such as Generalized Linear Models (GLM) I was able to model these covariates to assess their influence on the distribution of elephants in this landscape during the dry season. The best fitting models indicate that forage to a large extent and water to a lesser degree has a net positive influence (act as attractants) on the elephants ranging behaviour. Human disturbance on the other hand has a moderately high negative (acts as a deterrent) effect on the same. The study provides insights on the elephants ranging behaviour as influenced by ecological and human induced factors. Firstly, the study emphasizes the fact that elephants are tracking forage and is strongly influenced by its availability both within the protected area and in the surrounding human dominated landscape. It also gives us insights on the spatial and temporal segregation of humans and elephants in this landscape with human disturbance having a negative effect on elephant patch/grid preference index. This strategy employed by elephants seems to be helping them to continue to persist in this fragmented landscape. Elephants seem to be actively selecting areas which are conducive for their daily activities. This behaviour seems to be governed by their knowledge of areas with high productivity and historically low human disturbance, at-least at the scale of seasons. Studies like the one presented here could aid in effective management of forested areas for elephants and most other wide ranging species. It also aids in conservation planning of landscapes that require immediate attention in order to ensure that populations of large mammals and wide ranging species continue to thrive, keeping into account the very essential aspect of human welfare by helping in mitigating human-elephant conflict.

Effects of Recurring Forest Fire on Ground Vegetation Composition and Soil Properties in a South Indian Tropical Forest: ***Rajat Ramakant Nayak***

Fire is one of the most common phenomena of tropical dry forests and origin of fire in these forests dates back a few thousand years and probably associated with the early colonization of these forests by human beings. However, due to habitat shrinkage and increased human population that is dependent on forest, the extent and frequency of fires have increased over the years. This increased fire frequency is considered as one of the

major threats for the diversity and productivity of these landscapes. However very little quantitative data on the effect of these changed fire regime on vegetation composition and soil properties is available. Majority of fires in tropical forests are surface fires which mainly affects ground flora rather than trees. Hence, it is of importance to know the effects of these fires on ground vegetation. The evidences available on the impact of fire on ground vegetation are inconsistent and these effects cannot be generalized to the Indian subcontinent. It is in this context that I studied the effects of different frequencies of fire on ground vegetation. I chose the Kollegal-MM Hills-BRT landscapes which have a large contiguous tract of open forests (~3000 km2) where it was possible for me to carry out the study on ground vegetation. Time-series of remotely sensed data suggested that fires are indeed very frequent in these landscapes. Varying physiographic features and management practices have resulted in the existence of different fire regimes in the area. Thus the landscape provides an ideal situation for the study on effects of recurring fires on ground vegetation. I chose the Kollegal-MM Hills-BRT landscapes which have a large contiguous tract of open forests (~3000 km2) where it was possible for me to carry out the study on ground vegetation. Time-series of remotely sensed data suggested that fires are indeed very frequent in these landscapes. Varying physiographic features and management practices have resulted in the existence of different fire regimes in the area. Thus the landscape provides an ideal situation for the study on effects of recurring fires on ground vegetation. I used remotely sensed data for identifying areas with different fire frequencies. I collected information on vegetation composition and soil properties across all fire frequencies. Linear regression models and Mantel's test of correlation were used to explore and test hypotheses related to the relationship between fire frequencies and different vegetation and soil properties. The results suggest that higher fire frequency had a greater effect on ground vegetation composition and soil properties. Fire frequency was found to act against rainfall in determining the grass species compositional turn-over in space. In the absence of fire these landscapes might show a substantially different mosaic of vegetation composition compared to the present composition. The grass species compositional turn-over over space that would have been present due to the gradient in rainfall alone is considerably modified by higher fire frequencies. Several soil physical and chemical properties responded to fire frequency. Shrub cover decreased with higher fire frequency resulting in enhanced grass cover. The study shows that, the frequency of fire can indeed determine the vegetation composition of an area by encouraging fire tolerant grass species and reducing the shrub cover. Fire frequency also affects the soil properties, and this may in turn help maintain certain vegetation communities. Management of the landscape for various components of biodiversity and for landscape scale heterogeneity will require active management of fire-regimes. To enhance the diversity it is of immediate need to curb the occurrence of annual fires.

Habitat use of the Indian chevrotain (*Moschiola indica)* in Someshwara Wildlife Sanctuary:
Sachin Sridhara

Small bodied deer and antelope are distributed throughout the tropics. Their small size imposes constraints on their movement rates, dispersal capabilities, and more importantly on feeding ecology and anti-predatory strategies. Studies suggest that availability of high energy resources and presence of refuges are the most important factors that influence habitat use of such species. In this study I investigated whether presence of fruiting trees

and ground cover influenced the use of habitat by the Indian chevrotain. The study was conducted in Someshwara Wildlife Sanctuary located in Karnataka for a period of four months from 15 January, 2010 to 15 April, 2010. Nearly 200 grid-cells of size 50 x 50m were sampled in two study areas within Someshwara Wildlife Sanctuary. Data was collected in an occupancy based capture-recapture framework to deal with the issue of imperfect detection of animals or their signs. Several environmental variables were measured to help explain the pattern of habitat use by the Indian chevrotain. Results indicate that Indian chevrotain indeed use habitats that provide refuges/cover from predators. However the study also found no evidence that fruiting trees influence habitat use of Indian chevrotain. This study clearly suggests that habitat simplification can have negative impacts for small bodied ungulates by reducing the area available for use. Small bodied ungulates face tremendous hunting pressures the world over.

Effect of intraspecific variation in blackbuck behaviour on dispersal of invasive *Prosopis juliflora* in a semi-arid grassland: *Shivani V Jadeja*

Seed dispersal is a key stage in the life history of a plant. Disperser movement, ranging behaviour, feeding preferences and feeding behaviour have been shown to influence patterns of seed dispersal. Most studies which incorporate disperser behaviour in seed dispersal have considered all individuals of a species as uniform. However, many species exhibit wide intraspecific behavioural variation. It is important to understand the consequences of this variation in dispersers on the effectiveness of dispersal, particularly for threatened species and invasive species. I studied the extent to which different social groups within a disperser species affect dispersal of seeds owing to behavioural variation using an invasive *Prosopis juliflora* and blackbuck (*Antilope cervicapra*) in a semi-arid grassland, at Velavadar National Park, Gujarat, India. *Prosopis* is a woody invasive in many parts of the world and blackbuck are known to disperse *Prosopis* seeds through their pellets. Social groups of blackbuck have substantial differences in their ranging behaviour. Males defend territories and hence have highly restricted movement. These territories may be dispersed, or they may be clustered to form a lek, within which dungpiles are formed due to continuous defecation by the males. Female biased groups and bachelor males have larger home ranges than territorial males. To study how different social groups of blackbuck disperse *Prosopis* seeds, I focused on the three stages of the seed dispersal cycle, namely seed removal, seed deposition and seedling recruitment. Field work was carried out in Velavadar National Park, Gujarat between 1 Jan 2010 and 17 May 2010. Camera traps were set up at individual *Prosopis* trees to determine removal of pods by different blackbuck social groups. To estimate the time spent by different blackbuck social groups in different habitat types I conducted habitat watches. *Prosopis* seed deposition and seedling recruitment were measured in plot laid in different locations with varying use by territorial males. A factorial experiment was carried out to determine the effect of ingestion of seeds, presence of dung and light on seed germination. This study showed that adult males had relatively higher visitation to *Prosopis* trees and pod removal rate than did females and immature males. Since males form only about 30% of the blackbuck population, they appear to play a disproportionately large role in pod removal. Seed deposition was highest on dungpiles in both lekking and dispersed territories compared with other locations sampled (i.e., locations other than dung piles on territories, and locations outside territories in grasslands, shrublands and bare grounds). Seed deposition increased with

increasing distance from *Prosopis* trees. Dungpiles had highest seedling recruitment suggesting they are particularly suitable microsites for seed germination. These data on pod removal rates, seed deposition rates, and seed establishment suggest that blackbuck social groups differentially influence the dispersal of invasive *Prosopis*. These differences stem from differences in feeding and ranging behaviour of territorial males on the one hand and non-territorial groups (female-biased and bachelor groups) on the other. Most importantly, territorial males show directed dispersal to dungpiles which are away from trees, situated in open grassland, and which show the highest rates of seed germination and seedling recruitment. Uncontrolled spread of *Prosopis* can cause the loss of territorial sites and would drastically affect blackbuck reproduction, fitness and population size. My study suggests that one mechanism for this is the directed dispersal by male blackbuck.

Ecological and anthropogenic covariates influencing gharial *Gavialis gangeticus* distribution and habitat use in Chambal River, India: *Tarun Nair*

The critically endangered gharial, endemic to the Indian sub-continent, was common in the river systems of Pakistan, northern India, Bangladesh, Myanmar, Bhutan and Nepal. They are now restricted to a few, scattered locations in India and Nepal, having become increasingly rare due to land-use changes, reduction in water flow, modification of river morphology, loss of nesting sites, increased mortality in fishing nets, egg-collection for consumption. Information on the effects of biotic factors and human disturbances on gharial distribution and abundance are either scant or completely lacking, and thus are an impediment to effectively understand the conservation needs of the species. The objectives of my study were to answer the following questions: 1) What is the extent of potential gharial habitat within the study area? 2) How do different habitat attributes and conditions determine gharial distribution and abundance? 3) How do different environmental and human activities influence gharial distribution and habitat site use/preference within available potential gharial habitat? The 75 km stretch of the Chambal was divided into thirty 2.5 km segments and each segment was sampled once across four sampling occasions, between February and May, 2010, by row-boat, with a total survey effort of 300 km. These four sampling occasions cover the gradient from late winter to mid-summer. Boat survey and stationary bank observations at basking sites were used to collect data. Habitat variable data like river discharge, water depth, channel width, air and water temperatures, shoreline substratum and presence of basking sites were recorded for each of the 2.5 km segments at a scale of 0.5 km. On the basis of the depth profile and shoreline substratum data, one-fifth of the study area qualified as preferred gharial habitat. Availability of undisturbed basking sites in conjunction with deep water segments emerged as the main variable explaining gharial occurrence. All human activities appeared to negatively influence the use of areas by gharials. Sand mining and cultivation around the banks negatively impacted the use of such sites for basking. Gharials were seen less often and in fewer numbers in areas where fishing was high. Similar results were seen with movement of people and livestock along the river stretch. This study indicates the importance of inviolate areas that satisfy the bio-physical requirements of the gharial. I also describe a robust and easily replicable protocol for estimating gharial population size using photo-capture of basking animals. I demonstrate the conceptual, technical and logistic feasibility of applying photographic capture-recapture techniques for estimating gharial abundance in the wild.

CONCLUSIONS SUMMARIZING THE ACHIEVEMENTS AND INDICATION OF SCOPE FOR FUTURE WORK

This project has two major achievements. This project demonstrates that it is possible to do high quality research in the field of wildlife biology and conservation at the Masters level. However, the students need to be highly passionate and motivated to conduct such research. The process and criteria for selection of students for the course at NCBS ensures that such students get selected. In addition, the students need to be trained well in the theory and practice of wildlife biology and conservation, especially through hands on practicals, by well established academicians and conservationists. The course curricula, with about 30% of the time spent in forest areas, and the flexibility to invite eminent scientists and conservationists from other institutions also enabled high quality training of the students. We also had eminent scientists from several organizations to serve in the Dissertation Advisory Committee. Equally important, the grant from DST allowed the students to develop projects that they were passionate about, free from concerns about funding. The grant also provided fellowships to students in order to prepare manuscripts for publication. All these factors enabled us to submit 8 papers in peer reviewed journals and have 11 presentations in international seminars, with four best presentation awards, within the project duration itself. At least five more papers are being finalized for submission. *This would be an unparalleled record for a Masters course in India, perhaps anywhere in the world.*

The second achievement is that these dissertations have made significant contributions to the science of wildlife biology and conservation. The following contributions are particularly noteworthy since they have immediate implications for the conservation endangered species:

i. Three dissertations addressed tiger conservation. Aditya Joshi's study (in prep. for *Molecular Ecology*) demonstrates, using genetic data, that tigers disperse among protected areas in central India, separated by as much as 600 km of human modified landscapes. Two other studies (in prep. for *Biological Conservation*) made an assessment of the potential for tiger conservation in Cauvery and Kawal Wildlife Sanctuaries, based on current and potential prey densities. Their research has already contributed to an expansion of Cauvery Wildlife Sanctuary, and to the notification of Kawal as a Tiger Reserve.
ii. Tarun Nair's study (re-submitted after revision to *Journal of Applied Ecology*) provided the first rigorous estimate of the gharials population and an assessment of habitat use in Chambal River.
iii. Nishant Srinivasaiah's study (in review in PLoS One) provides an understanding of decision making by elephants at the population and individual levels, which might help in mitigating human-elephant conflict in human-modified landscapes. Nisarg Prakash's study (published in *Tropical Conservation Science*) found widespread occurrence of otters in human-modified landscapes, due to the retentions of forest patches and riparian vegetation.

S&T BENEFITS ACCRUED

Table 2. List of research publications resulting from the project

No	Authors	Title of paper	Journal	Volume	Year
1	**Gangal, M.S.**, Arthur, R & Alcoverro, T.	Structure and dynamics of South East Indian seagrass meadows across a sediment gradient.	*Aquatic Botany*	*98*:34-39	2012
2	**Krishnadas, M.** Chandrashekhar, K & Kumar, A.	The Response of the Frugivorous Lion-Tailed Macaque (*Macaca silenus*) to a Period of Fruit Scarcity.	*American Journal of Primatology,*	73:1-11	2011
3	**Nair, T.,** J.B., Thorbjarnarson, Aust, P & Krishnaswamy, J.	Estimating gharial *Gavialis gangeticus* populations using individual identification and photo-graphic capture – recapture models: Implications for conservation and management.	*Journal of Applied Ecology (re-submitted after revision)*		
4	**Prakash, N.**, Mudappa, D., Shankar Raman, T. R & Kumar, A.	Conservation of the Asian small-clawed otter (*Aonyx cinereus*) in human-modified landscapes, Western Ghats, India.	*Tropical Conservation Science*	5:67-78.	2012
5	Choudhary, S., Dey, S., Dey.S., Sagar, V., **Nair. T** & Kelkar, N.	River dolphin distribution in regulated river systems: implications for dry-season flow regimes in the Gangetic basin.	*Aquatic Conservation*	22:11–25	2012
6	**Nayak, R.R.** Vaidyanathan, S & Krishnaswamy, J.	Fire and grazing modify grass community response to abiotic determinants in 5 savannas: implications for sustainable use.	*Ecological Applications (in review)*		
7	**Punjabi, G.,** Chellam, R & Vanak, A.T.	Adaptation to local changes: den site selection by the Indian fox in human-dominated landscapes.	*Animal Conservation (re-submitted after revision)*		
8	**Srinivasaiah, N.M.,** Anand, V.D., Vaidyanathan, S. & Sinha, A.	Usual Populations, Unusual Individuals: Insights into the Behavior and Management of Asian Elephants in Fragmented Landscapes.	*PLoS One (in review)*		

Table 3. Presentations of dissertation findings in international seminars

1. Herlekar, I. Student Conference on Conservation Science, Cambridge, March 2011.
2. Jadeja, S. Student Conference on Conservation Science – Asia, Bangalore, July 2010. – **Best Presentation Award**
3. Jadeja, S. Association of Tropical Biology and Conservation Thailand, March 2011.
4. Jadeja, S. Student Conference on Conservation Science, Cambridge, March, 2011. – **Best Presentation Award.**
5. Jadeja, S. Annual Symposium of British Ecology Society, Cambridge, March 2011.
6. Krishnadas, M. Association of Tropical Biology and Conservation, Arusha, Tanzania, June 2011
7. Prakash, N. Borneo Carnivore Symposium, Kota Kinabalu, Malaysia, June 2011.
8. Punjabi, G. Student Conference on Conservation Science – Asia, Bangalore, July 2010. – **Best Presentation Award**
9. Tarun Nair. Student Conference on Conservation Science – Asia, Bangalore, September 2011. – **Best Presentation Award**
10. Tarun Nair. International Congress of Society of Conservation Biologists in New Zeland, December 2011.
11. Tarun Nair. Student Conference on Conservation Science, Cambridge University, March 2012.
12. Srinivasaiah, N.M. International Wildlife Management Congress being held at Durban, South Africa July 2012 (to attend)

Manpower trained on the project

a) We have trained 15 Masters students in conducting high quality research in wildlife biology and conservation. The training included three semesters of course work to develop theoretical knowledge and practical skills in major disciplines of quantitative ecology and social science, development of skills in science communication through presentations and publications in scientific journals and popular print media. The most important part of the training was in writing research proposals for conducting field based studies in wildlife biology and conservation, in carrying out data collection according to a study design and sampling framework, in data analysis and in the writing and submission of manuscripts to peer reviewed international journals. The effectiveness of the training is evident from the publications and presentations in international seminars.

b) No. of Ph.D. produced: None

c) Other Technical Personnel trained: None

Patents taken, if any: None

DETAILS OF ASSETS ACQUIRED

S No	Sanctioned List	Procured (Yes/ No) Model & make	Cost (Rs)	Working (Yes/ No)	Utilisation Rate (%)
1-2	PCR Machine -1	Yes - Eppendorf Master-cycler Gradient & pipettes (1)	4,52,294	Yes	100%
3-4	Research & Stereo Microscopes	LABOMED Trinocular Research Microscope Lx400 - 5 LABOMED Binocular Stereo Microscope CSM 2 - 5	3,37,275	Yes	60%
5	Freezer (-20^{0}C)	Vestfrost Freezer – 1	63,225	Yes	100%
6	Lap top PC	Dell Inspiron - 2	88,336		
7	Laser Range Finder	Nikon Monarch Laser 800 - 3	65,430	Yes	100%
8	GPS	Garmin GPS Vista HCx -5	1,08,563	Yes	100%